

PRELIMINARY DATA SUMMARY

March 1987

U.S. Army Engineer Waterways Experiment Station  
Coastal Engineering Research Center  
Field Research Facility  
Duck, North Carolina

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CERC Field Research Facility  
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Field Research Facility Measurement and Analysis Work Unit at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility in Duck, North Carolina. The data were collected and the analyses performed by the FRF staff. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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## I. INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Fig.1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The FRF consists of a 561-m (1,840 ft) long concrete research pier supported on 0.91 m (3 ft) diameter steel piles. The pier deck is 6.1 m (20 ft) wide, 7.74 m (25.4 ft) above mean sea level (MSL), and extends from behind the dunes to approximately the 7.6 m (25 ft) depth contour. In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Most of the data are daily observations or the results of preliminary data analysis. In many instances, continuous analog records and more extensive analyses will be made available later by the CERC Coastal Engineering Information and Analysis Center (CEIAC).

Table 1 is a list of instruments used, their status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depth at the wave gages and current meters vary and may best be determined from the information contained in Figure 8. Other installation information is contained in Table 1. All times unless otherwise specified are referenced to Eastern Standard Time (EST).

Section II presents the meteorological data; Sections III through VI, oceanographic data; Section VII, nearshore profiles and bathymetry; and Section VIII, if included, documents special events that occurred at the FRF during the month.

Questions and/or comments concerning the data may be directed to Mr. Herman C. Miller at (919) 261-3511.

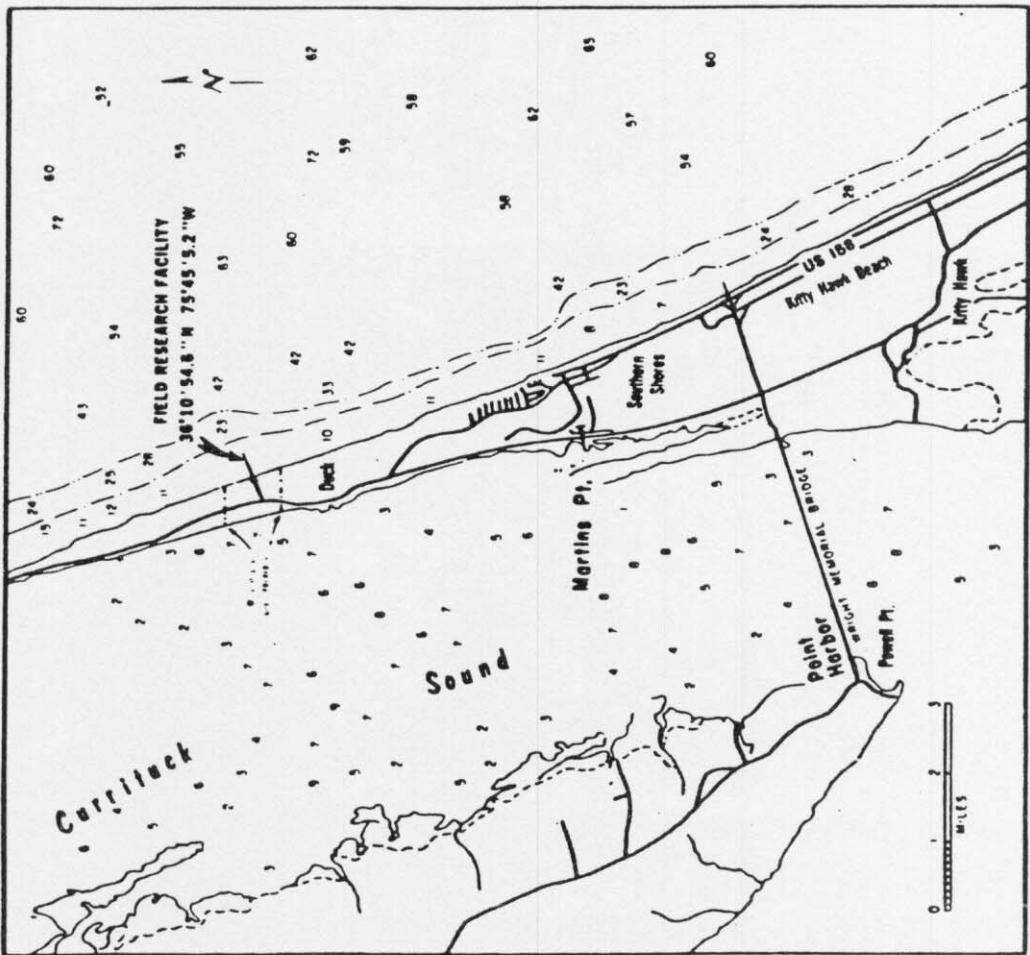
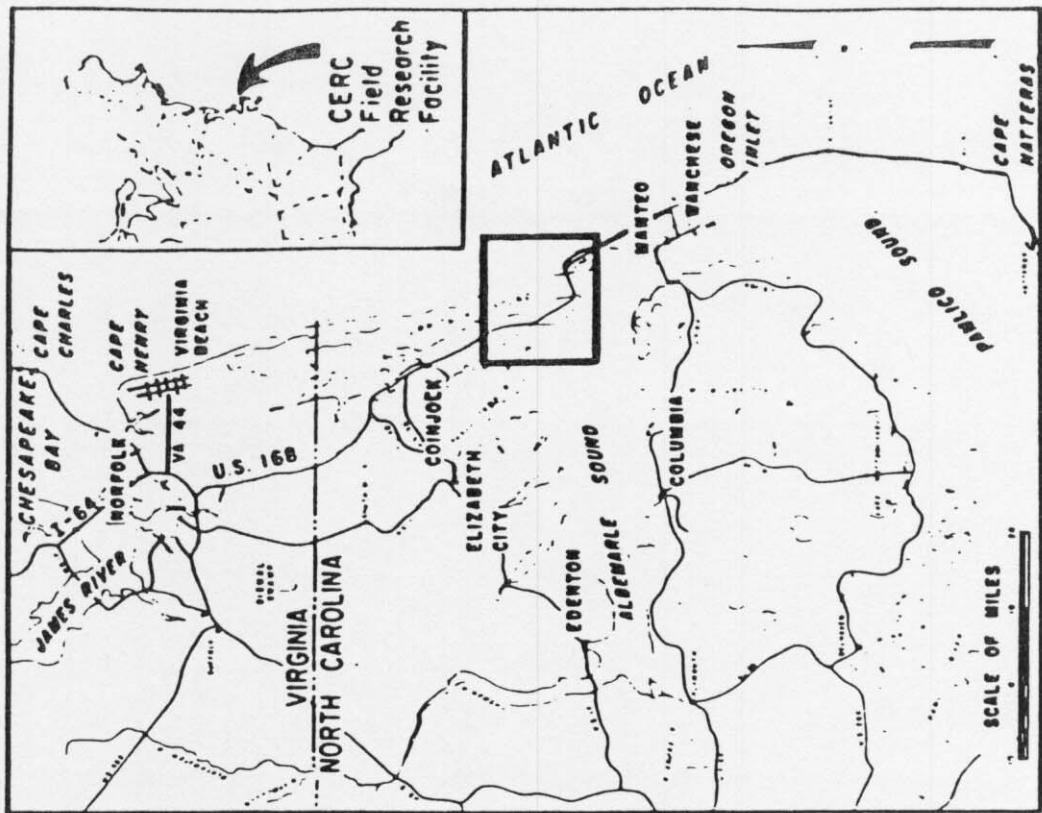


Figure 1. FRF Location Map

TABLE 1  
INSTRUMENT STATUS/DATA AVAILABILITY

March 1987

GAGE NUMBER	DESCRIPTION/REMARKS	DEPTH AT SENSOR	DAY OF THE MONTH											
			1/2/3/4/5/6/7/8/9/10/11/12/13/14/15/16/17/18/19/20/21/22/23/24/25/26/27/28/29/30/31											
	Barometric Pressure		Instrument Status Data Collected Analog Record	■	■	■	■	■	■	■	■	■	■	■
	Precipitation		Instrument Status Data Collected Analog Record	■	■	■	■	■	■	■	■	■	■	■
	Air Temperature		Instrument Status Data Collected Maximum/Minimum	■	■	■	■	■	■	■	■	■	■	■
	Anemometer on Lab Bldg - Elevation 19a (MSL)		Instrument Status Data Collected Analog Record	■	■	■	■	■	■	■	■	■	■	■
645	Baylor staff located at station 7+80 on FRF pier	See profile data.	Instrument Status Data Collected	■	■	■	■	■	■	■	■	■	■	■
625	Baylor staff located at station 19+00 on FRF pier	See profile data.	Instrument Status Data Collected	■	■	■	■	■	■	■	■	■	■	■
640	Waverider buoy located 1.0 km from shore	Approx. 8.5 m. MSL	Instrument Status Data Collected	■	■	■	■	■	■	■	■	■	■	Gage Inoperative
630	Waverider buoy located 6.0km from shore	Approx. 18 m. MSL	Instrument Status Data Collected	■	■	■	■	■	■	■	■	■	■	■
679	Current meter 500m south (0.5km offshore)	Approx. 6 m MSL	Instrument Status Data Collected	■	■	■	■	■	■	■	■	■	■	■
865-1370	NOAA primary tide station located at seaward end of FRP pier.		Instrument Status Data Collected	■	■	■	■	■	■	■	■	■	■	■

Instrument Status: Operational ■ - Daily Observation: YES  NO   
 Analog Record: ALL  PARTIAL   
 Data Collected: ALL  SOME   
 Preliminary Analysis: ALL  SOME

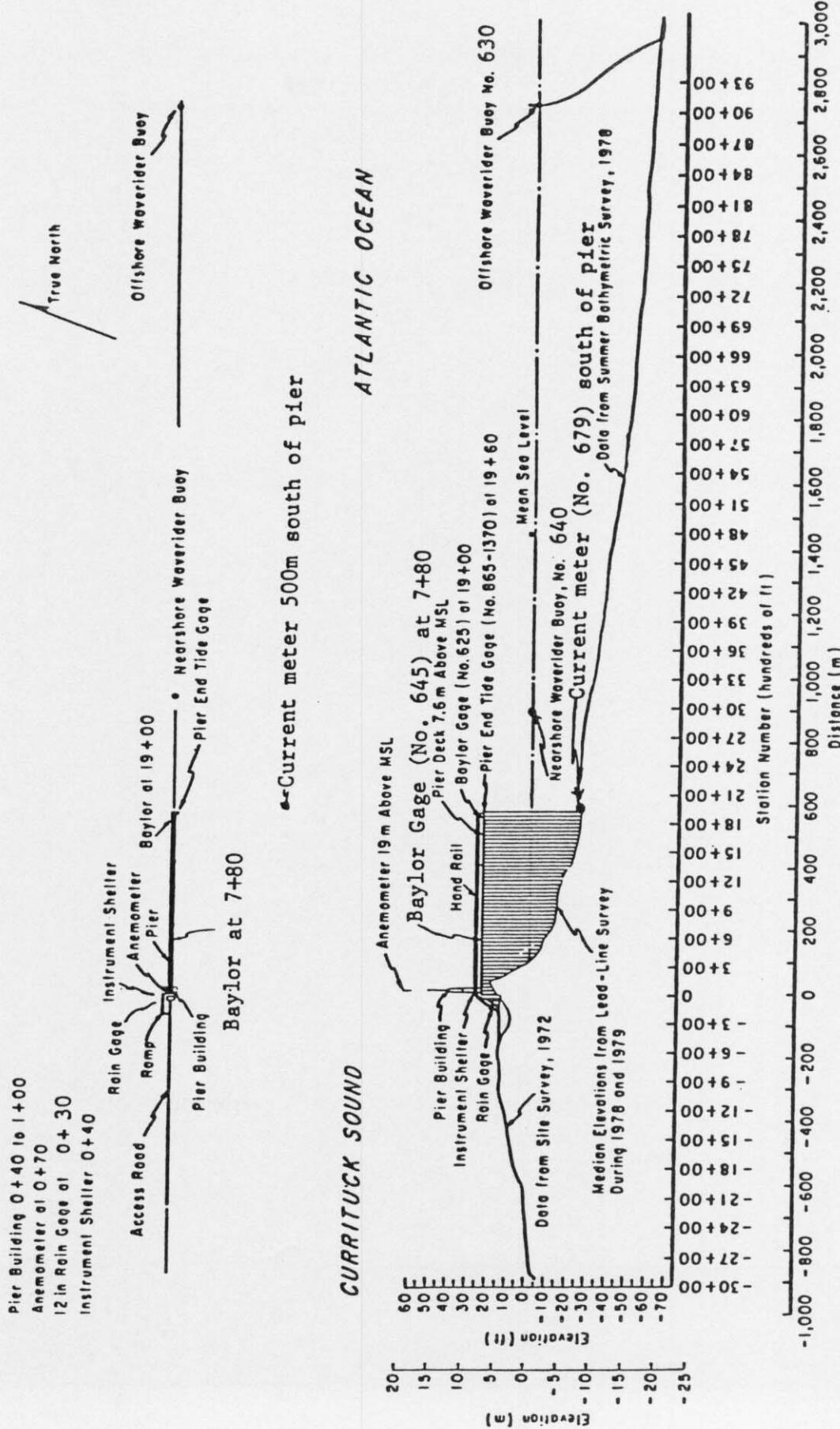


Figure 2. Instrument locations at FRF.

## II. METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Fig. 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

The wind measurements are obtained from a Weather Measure Skyvane located on the FRF laboratory building (Fig. 2), 19.1 m above mean sea level (MSL).

The high and low temperatures are obtained from daily readings of NWS maximum and minimum thermometers and represent the extreme temperature values since the last reading.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in) -  
 $mm \times .03937 = in$
2. Millibars (mb) to inches of mercury (in Hg) -  
 $mb \times 0.02953 = in Hg$
3. Degrees Celcius (C) to degrees Fahrenheit (F) -  
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -  
 $m/s \times 1.943 = kn$

TABLE 2: Meteorological Data

MAR 1987

Day	Hour	Wind Speed (m/s)	Wind Direction (deg TN)	Temperature (deg C)	Atm Pressure (mb)	Precipitation (mm)
1	100	6	149	6.8	1016.0	0
	700	9	170	16.2	1008.5	16
	1300	7	201	16.4	1002.8	8
	1900	7	209	14.5	1001.4	0
2	100	5	244	10.6	1005.5	0
	700	6	266	9.2	1009.9	0
	1300	7	274	14.2	1011.9	0
	1900	4	259	11.3	1016.0	0
3	100	4	305	9.1	1019.3	0
	700	4	221	8.0	1020.7	0
	1300	6	244	14.8	1019.3	0
	1900	5	67	7.3	1020.7	0
4	100	10	29	6.0	1023.1	0
	700	10	22	4.6	1025.4	0
	1300	11	20	4.6	1027.5	0
	1900	11	9	3.0	1029.2	0
5	100	10	7	1.3	1029.8	0
	700	10	359	1.8	1029.8	0
	1300	10	5	4.1	1031.2	0
	1900	8	32	3.1	1032.9	0
6	100	8	22	3.7	1033.6	0
	700	8	39	4.3	1032.9	0
	1300	5	20	5.9	1033.6	0
	1900	3	88	3.8	1031.5	0
7	100	2	194	2.3	1029.8	0
	700	3	240	6.4	1028.5	0
	1300	2	347	14.9	1025.1	0
	1900	3	188	10.7	1022.7	0
8	100	3	227	8.4	1019.3	0
	700	2	216	9.7	1018.3	0
	1300	2	119	14.5	1014.6	0
	1900	3	118	9.0	1010.5	0
9	100	4	203	14.1	1006.1	0
	700	4	212	12.7	1004.4	0
	1300	4	247	16.7	1002.4	0
	1900	6	185	15.4	1001.4	0
10	100	17	36	7.2	1002.4	0
	700	19	10	2.7	1011.2	13
	1300	20	358	1.1	1017.0	3
	1900	17	3	1.0	1022.1	0
11	100	15	27	1.9	1024.1	0
	700	15	25	2.8	1025.1	0
	1300	14	21	3.3	1026.1	0
	1900	12	20	3.9	1026.1	0
12	100	10	10	4.1	1024.4	0
	700	10	347	3.8	1023.7	0
	1300	10	360	3.7	1022.4	6
	1900	10	357	3.5	1022.1	0
13	100	11	2	3.2	1020.0	0
	700	7	332	3.5	1018.7	0
	1300	9	345	6.0	1018.0	0
	1900	8	354	4.4	1019.7	0
14	100	6	333	3.5	1020.4	0
	700	7	345	3.1	1022.1	0
	1300	7	16	4.8	1021.7	0
	1900	4	91	3.6	1021.0	0
15	100	3	160	2.2	1021.4	0
	700	3	179	4.9	1021.0	0
	1300	4	243	14.3	1019.0	0
	1900	6	5	5.3	1020.4	0
16	100	7	58	5.7	1020.4	0
	700	10	31	5.1	1019.3	0
	1300	12	21	3.0	1020.4	0
	1900	7	360	3.4	1021.7	0
17	100	4	305	1.9	1023.1	0
	700	8	359	3.2	1023.7	0
	1300	6	20	6.2	1021.7	0
	1900	2	289	3.2	1021.4	0
18	100	4	247	4.8	1021.0	0
	700	6	360	5.0	1021.7	0
	1300	4	36	7.0	1021.0	0
	1900	3	124	5.1	1019.0	0
19	100	4	212	5.3	1018.0	0
	700	3	240	6.5	1015.6	0
	1300	2	299	6.9	1013.6	0
	1900	4	28	4.9	1012.2	4
20	100	4	329	3.6	1011.9	0
	700	5	309	4.0	1012.9	0
	1300	7	25	6.6	1011.2	0
	1900	4	115	5.3	1010.9	0

TABLE 2: Meteorological Data

MAR 1987

Day	Hour	Wind Speed (m/s)	Wind Direction (deg TN)	Temperature (deg C)	Atm Pressure (mb)	Precipitation (mm)
21	100	3	192	6.2	1009.2	0
	700	8	9	5.5	1008.5	0
	1300	7	19	5.7	1009.9	0
	1900	3	38	5.8	1009.9	0
	22	100	6	261	6.3	1008.5
22	700	6	291	5.5	1008.9	0
	1300	10	11	5.7	1012.9	0
	1900	5	8	4.8	1014.6	0
	23	100	4	336	5.3	1014.3
23	700	6	355	6.3	1016.6	0
	1300	7	6	8.3	1017.0	0
	1900	3	358	5.7	1017.3	0
	24	100	2	294	4.5	1017.0
24	700	5	4	6.9	1018.0	0
	1300	3	35	8.6	1018.0	0
	1900	2	73	6.9	1018.3	0
	25	100	3	29	6.8	1018.7
	700	3	10	7.4	1020.0	0
25	1300	System down for repair				0
	1900	5	140	8.2	1017.0	0
	26	100	5	142	7.7	1015.6
	700	4	213	12.9	1016.0	0
	1300	2	252	19.8	1013.6	0
26	1900	5	176	15.7	1013.3	0
	100	4	222	14.3	1014.3	0
	700	3	257	15.8	1014.9	0
	1300	4	95	8.9	1013.6	0
	1900	7	93	11.6	1010.5	27
27	100	3	250	13.5	1007.8	7
	700	3	312	12.8	1008.9	5
	1300	7	353	11.9	1013.6	0
	1900	6	39	8.9	1017.7	0
	28	100	5	87	6.4	1020.7
28	700	3	53	5.7	1023.1	0
	1300	4	39	9.4	1023.4	0
	1900	5	78	9.3	1021.4	0
	100	6	101	9.9	1018.7	0
	700	5	140	10.8	1014.9	0
29	1300	9	144	12.0	1010.2	0
	1900	6	150	11.1	1006.5	0
	100	8	177	18.2	1004.1	15
	700	9	165	18.3	998.4	6
	1300	10	248	14.6	1002.4	0
30	1900	7	281	12.4	1005.5	0
	31					

### III. WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645) and two Waverider buoys (Gages 630 and 640) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hrs near 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for 34 minutes.

Wave height ( $H_{mo}$ ) is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. The wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. The period ( $T_p$ ) is that associated with the maximum energy density in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed for all data records collected. Figure 3 is a time history of the  $H_{mo}$  and  $T_p$  values for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

TABLE 3: WAVE DATA

Part 1

MAR 1987

Day	Hour	645		625		640		630	
		Baylor at 7+80 Hmo(m)	T(sec)	Baylor at 19+00 Hmo(m)	T(sec)	Nearshr Hmo(m)	Wvrdr T(sec)	Farshr Hmo(m)	Wvrdr T(sec)
1	01	1.18	6.92	1.43	7.32	1.53	7.53	1.82	6.74
	07	1.47	8.53	1.81	8.53	1.91	8.53	2.05	8.53
	13	1.50	10.24	1.76	12.20	1.76	9.48	2.21	10.24
	19	1.48	9.48	1.59	10.66	1.56	10.24	1.85	9.48
2	01	1.26	11.14	1.18	11.64	1.21	11.14	1.51	11.14
	07	0.73	9.84	0.94	9.84	1.01	9.48	1.19	9.48
	13	0.66	17.06	0.72	9.48	0.77	11.14	0.90	10.24
	19	0.52	8.53	0.72	9.48	0.70	9.14	0.78	9.14
3	01	0.41	15.06	0.64	11.64	0.65	9.14	0.77	9.84
	07	Testing of system							
4	13	0.39	16.00	0.54	8.53	0.57	10.66	0.64	8.83
	19	0.39	10.66	0.54	15.06	0.52	8.53	0.60	7.53
	01	0.51	2.37	0.62	10.66	0.61	9.48	0.68	9.14
	07	1.16	5.95	1.40	6.24	1.41	5.95	1.75	5.33
5	13	1.11	5.22	1.18	5.02	1.26	5.22	1.70	5.22
	19	1.03	4.92	1.20	5.33	1.23	5.69	1.44	5.45
	01	1.18	5.95	1.28	5.95	1.36	5.95	1.68	5.45
	07	1.15	5.82	1.34	6.57	1.37	6.24	1.69	6.24
6	13	1.21	7.53	1.49	7.76	1.51	7.53	1.59	7.76
	19	0.92	5.02	1.25	7.53	1.25	7.76	1.50	7.76
	01	0.83	9.84	1.23	10.66	*	*	1.31	7.53
	07	1.06	4.74	1.42	9.84	*	*	1.51	10.24
7	13	0.83	9.84	1.22	9.84	1.30	9.84	*	*
	19	0.77	9.48	0.90	9.48	0.91	9.14	*	*
	01	0.48	9.14	0.71	8.83	0.75	8.00	*	*
	07	0.50	8.83	0.61	7.76	0.61	8.26	*	*
8	13	0.30	7.76	0.48	8.00	0.51	8.26	*	*
	19	0.32	7.53	0.44	7.76	0.45	7.32	0.55	7.76
	01	0.24	6.92	0.31	6.57	0.35	6.74	0.44	7.11
	07	0.26	12.20	0.30	11.64	0.32	11.64	0.40	7.11
9	13	0.19	11.64	0.28	11.64	0.29	11.64	0.36	7.76
	19	0.28	6.92	0.29	11.14	0.32	11.14	0.39	7.53
	01	0.34	6.24	0.39	8.53	0.43	6.74	0.61	7.32
	07	0.42	7.53	0.59	7.11	0.64	7.32	0.84	6.40
10	13	0.42	5.69	0.49	7.11	0.52	6.24	0.70	6.09
	19	0.45	6.24	0.50	7.11	0.58	6.57	0.63	6.40
	01	1.11	4.00	1.31	3.88	1.30	4.00	1.28	3.94
	07	1.74	9.14	3.36	9.48	3.76	9.84	4.49	9.14
11	13	1.77	9.84	3.19	10.66			4.69	11.14
	19	1.85	12.20	3.18	12.20			4.49	12.20
	01	1.83	13.48	3.25	12.20	Gage Inoperative		4.24	11.64
	07	1.88	13.48	3.04	12.20			3.69	11.64
	13	1.75	11.14	2.80	11.64			3.46	12.20
	19	1.82	12.80	2.87	12.80			3.09	11.14

\* Electronic problems

TABLE 3: WAVE DATA

Part 2

MAR 1987

Day	Hour	645		625		640		630	
		Baylor at 7+80 Hmo(m)	T(sec)	Baylor at 19+00 Hmo(m)	T(sec)	Nearshr Wvrdr Hmo(m)	T(sec)	Farshr Wvrdr Hmo(m)	T(sec)
12	01	1.86	10.24	2.57	12.20			2.80	10.66
	07	1.77	12.20	2.30	12.80			2.56	12.20
	13	1.72	10.66	2.38	11.14			2.51	11.64
	19	1.71	12.20	2.34	11.14			2.64	11.64
13	01	1.68	12.20	2.38	11.14			2.69	11.14
	07	1.86	7.76	2.17	11.14			2.40	12.20
	13	1.64	8.00	2.26	10.66			2.30	11.14
	19	1.80	9.84	2.26	9.48			2.37	8.83
14	01	1.69	9.84	2.17	9.84			2.24	10.24
	07	1.70	10.66	2.12	11.14			2.36	10.66
	13	1.69	11.64	2.21	11.64			2.13	10.24
	19	1.76	12.20	2.35	11.64			2.04	12.20
15	01	1.99	12.80	2.21	12.80			2.07	12.20
	07	2.02	12.20	2.26	12.80			1.94	11.64
	13	2.03	14.22	2.21	14.22			2.02	12.80
	19	1.61	12.20	1.88	12.80			1.98	12.80
16	01	1.58	13.48	1.89	13.48			1.76	12.80
	07	1.38	11.64	1.89	11.64			2.10	11.64
	13	1.46	11.64	2.30	6.74			2.39	6.09
	19	1.28	5.95	1.82	11.64	Gage Inoperative		2.00	11.14
17	01	1.21	12.20	1.43	12.20			1.41	12.20
	07	1.12	12.20	1.45	11.64			1.66	11.64
	13	1.23	5.56	1.28	11.64			1.46	5.95
	19	1.09	6.74	1.25	11.14			1.32	6.92
18	01	0.77	6.74	0.83	11.14			0.98	11.14
	07	0.77	4.66	0.94	10.66			1.06	10.66
	13	0.95	5.82	0.98	5.82			1.01	5.69
	19	0.69	5.69	0.89	7.76			0.95	8.00
19	01	0.67	5.56	0.86	8.83			0.85	8.26
	07	0.47	5.95	0.75	8.53			0.71	8.53
	13	0.40	8.83	0.61	9.14			0.66	8.83
	19	0.39	8.26	0.59	9.14			0.60	8.00
20	01	0.36	7.53	0.51	7.53			0.53	8.00
	07	0.38	11.14	0.51	6.74			0.57	6.40
	13	0.61	2.75	0.66	7.32			0.74	3.82
	19	0.43	4.20	0.54	11.14			0.65	7.53
21	01	0.34	4.66	0.51	10.66			0.60	7.53
	07	0.52	2.56	0.63	7.32			0.64	6.57
	13	0.94	5.02	0.99	5.12			1.23	4.92
	19	0.66	5.12	0.78	5.22			0.91	5.12
22	01	0.46	5.22	0.57	5.02			0.69	5.56
	07	0.40	5.02	0.43	9.14			0.56	8.53
	13	0.87	4.57	0.93	4.57			1.15	4.27
	19	1.41	6.92	1.30	7.11			1.44	6.74

\* Electronic problems

TABLE 3: WAVE DATA

Part 3

MAR 1987

Day	Hour	645		625		640		630	
		Baylor at 7+80 Hmo(m)	T(sec)	Baylor at 19+00 Hmo(m)	T(sec)	Nearshr Wvrdr Hmo(m)	T(sec)	Farshr Wvrdr Hmo(m)	T(sec)
23	01	1.13	7.53	1.37	7.76			1.50	8.26
	07	1.44	9.84	1.81	9.84			1.65	9.48
	13	1.65	12.20	2.93	12.20			2.44	12.20
	19	1.60	11.64	2.21	11.14			2.00	11.64
24	01	1.63	10.66	2.19	10.66			2.13	10.66
	07	1.58	11.14	2.10	11.14			1.73	11.14
	13	1.48	12.80	1.88	11.64			1.79	10.66
	19	1.57	11.14	1.87	11.64			1.64	11.64
25	01	1.11	11.14	1.50	11.14			1.47	10.66
	07	0.91	11.64	1.27	10.66			1.26	9.84
	13	System down for repair							
	19	0.72	10.66	1.18	10.66			1.15	10.66
26	01	0.68	10.66	1.07	10.66			1.15	10.66
	07	0.66	11.14	1.02	11.14			1.11	10.66
	13	0.66	11.14	1.06	9.48			1.18	10.24
	19	0.73	11.14	1.10	11.14			1.20	11.14
27	01	0.61	11.14	0.98	10.66			1.10	10.66
	07	0.52	10.66	0.90	11.14	Gage Inoperative		1.00	9.84
	13	0.54	10.66	0.76	10.66			0.87	10.66
	19	0.50	10.24	0.73	9.84			0.81	10.24
28	01	0.51	7.11	0.77	9.48			1.09	6.92
	07	0.56	8.53	0.82	8.83			1.15	8.83
	13	0.75	3.77	0.84	8.83			1.02	8.83
	19	0.85	5.56	0.94	5.12			1.39	5.12
29	01	1.25	6.24	1.09	6.92			1.23	6.92
	07	1.02	9.48	1.14	9.14			1.32	9.14
	13	1.03	9.84	1.13	9.84			1.13	10.24
	19	0.88	9.84	1.20	9.84			1.33	9.48
30	01	1.07	10.66	1.19	10.24			1.18	11.64
	07	0.81	10.66	1.21	9.84			1.38	10.24
	13	1.24	6.92	1.41	10.66			1.77	7.11
	19	1.72	8.53	1.95	8.53			2.40	8.83
31	01	1.66	9.84	2.10	10.24			2.62	10.24
	07	1.76	9.14	1.87	11.14			2.37	9.84
	13	1.80	11.14	1.84	10.24			2.14	10.24
	19	1.52	12.80	1.60	12.20			1.83	9.48
Mean		1.06	9.05	1.38	9.72	1.01	8.33	1.57	9.12
Std dev		0.53	3.02	0.75	2.25	0.66	1.95	0.88	2.27

\* Electronic problems

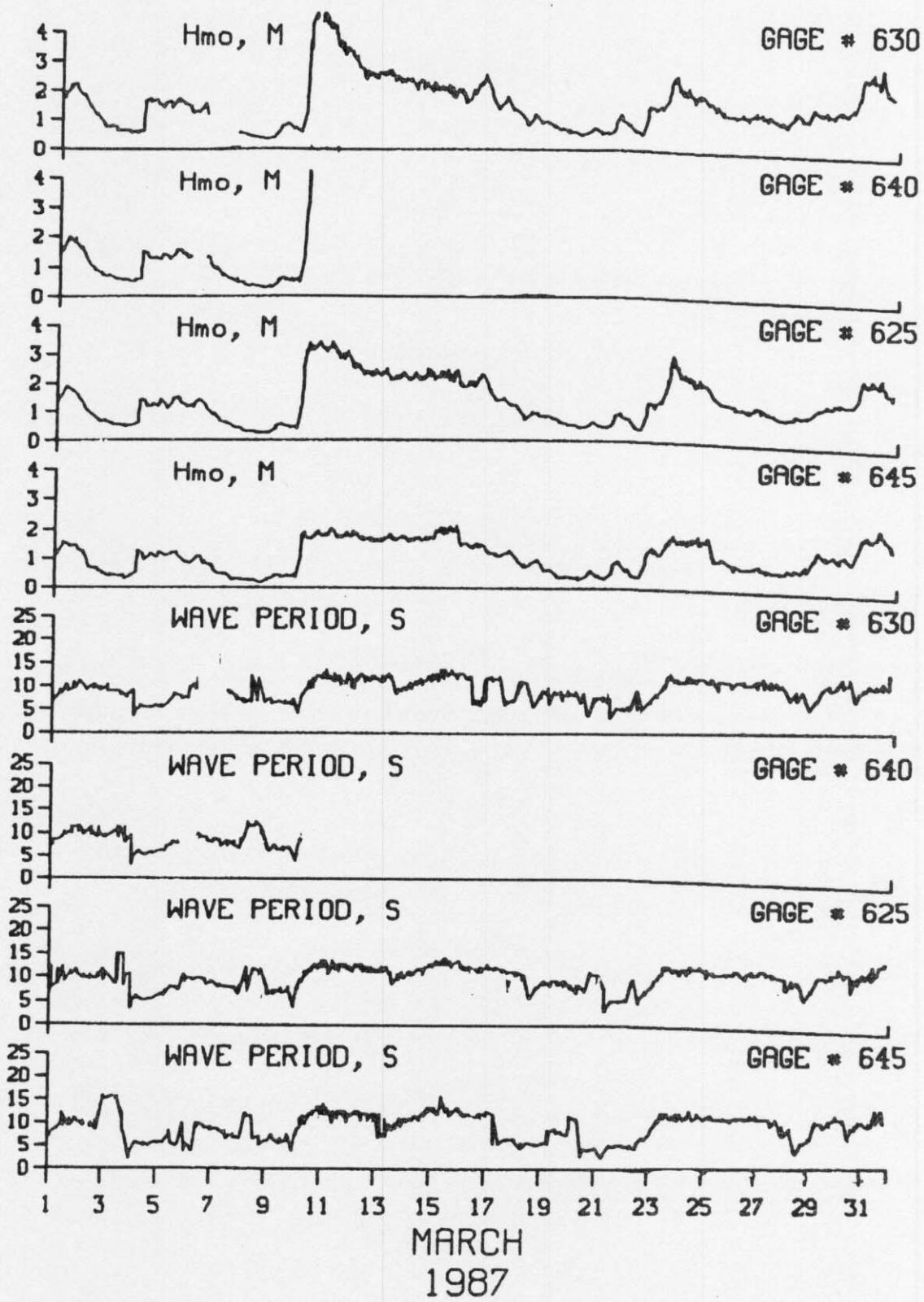


FIGURE 3. Time History of Wave Heights and Periods

#### IV. CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, alongshore currents flow either toward 340 (i.e. northward) or toward 160 (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second.

TABLE 4: Current Data  
MAR 1987

Day	Time	Pier Measurements				Beach Measurements				Current Meter	
		Alongshore Cross-shore Resultant	Dye at (579 m) (surface)	Distance from Baseline (m)	Dye at Mid-Surf Zone (surface)	Location	12m offshore (surface)	Speed	Dir	at South Tripod Depth -4.8m (NGVD) ID #679	Speed
1	0100-Along Cross Result									4	S on
										1	
										4	174
1	0700-Along Cross Result	102 0	N 340	226	122 0					11	
		102	340		122					3	N off
										11	355
1	1300-Along Cross Result									29	
										5	N off
										29	350
1	1900-Along Cross Result									21	
										5	N off
										22	353
2	0100-Along Cross Result									11	
										2	N off
										11	350
2	0700-Along Cross Result	0 10	N off	140	25 8 27	N off 357	North	18	S	17 8 19	N off 5
		10	70								
2	1300-Along Cross Result									2	S off
										2	115
2	1900-Along Cross Result									2	
										9	S on
										9	237
3	0100-Along Cross Result									8	
										4	S on
										9	187
3	0700-Along Cross Result	9 5 10	N off 11	140	15 5 16	N off 359	North	19	N		
3	1300-Along Cross Result									5	S off
										2	138
3	1900-Along Cross Result									33	
										5	S on
										33	169
4	0100-Along Cross Result									34	
										11	S on
										36	178
4	0700-Along Cross Result	47 5 47	S on 166	165	61 0 61	S 160	North	87	S	37 2 37	S on 163
4	1300-Along Cross Result									37	
										3	S on
										37	165
4	1900-Along Cross Result									41	
										0	S
										41	160
5	0100-Along Cross Result									38	
										8	S on
										39	172
5	0700-Along Cross Result	68 0 68	S 160	274	41 0 41	S 160	North	55	S	35 5 35	S on 168
5	1300-Along Cross Result									42	
										8	S on
										43	171
5	1900-Along Cross Result									20 7 21	
											S on 179

KEY = All speeds in CM/SEC

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

TABLE 4: Current Data  
MAR 1987

Day	Time	Pier Measurements				Beach Measurements				Current Meter	
		Dye at (579 m) Speed	Dye at (surface) Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	(500m Updrift)	Dye 12m offshore (surface)	Location	Speed	Dir
6	0100-Along Cross Result									20	S on 171
6	0700-Along Cross Result	28 1 28	S on 163	213	10 18 21	S off 98	no observation			20 9 22	S on 184
6	1300-Along Cross Result									23 9 25	S on 181
6	1900-Along Cross Result									3 5 6	S on 219
7	0100-Along Cross Result									11 0 11	N
7	0700-Along Cross Result	38 10 39	N off 354	165	17 3 18	N off 351	South	12	N	20 3 20	N on 331
7	1300-Along Cross Result									6 6 8	N on 295
7	1900-Along Cross Result									11 2 11	N on 330
8	0100-Along Cross Result									8 0 8	N
8	0700-Along Cross Result	30 0 30	N 340	165	20 3 21	N off 349	South	18	N	7 0 7	N
8	1300-Along Cross Result									0 1 1	on 250
8	1900-Along Cross Result									11 7 13	S on 192
9	0100-Along Cross Result									7 3 8	S on 183
9	0700-Along Cross Result	47 0 47	S 160	152	30 30 43	N off 25	North	11	N	20 3 20	S on 169
9	1300-Along Cross Result									13 1 13	S on 164
9	1900-Along Cross Result									8 3 9	S on 181
10	0100-Along Cross Result									34 11 36	S on 178
10	0700-Along Cross Result				no observations were made					152 26 154	S on 170
10	1300-Along Cross Result									132 28 135	S on 172
10	1900-Along Cross Result									114 30 118	S on 175

KEY = All speeds in CM/SEC

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

TABLE 4: Current Data  
MAR 1987

Day	Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements				Current Meter at South Tripod Depth -4.8m (NGVD) ID #679	
		Dye at (579 m) (surface) Speed	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	Speed	Dir	
11	0100-Along Cross Result								58	S	
									26	on	
									64	184	
11	0700-Along Cross Result		no observations were made						62	S	
									26	on	
									67	183	
11	1300-Along Cross Result								61	S	
									21	on	
									65	179	
11	1900-Along Cross Result								53	S	
									16	on	
									55	177	
12	0100-Along Cross Result								36	S	
									11	on	
									38	177	
12	0700-Along Cross Result	61 0 61	S 160	238	27 4 27	S off 151	no observation		35 5 35	S on 168	
12	1300-Along Cross Result								33	S	
									1	off	
									33	158	
12	1900-Along Cross Result								51	S	
									6	on	
									51	167	
13	0100-Along Cross Result								50 9 51	S on 170	
13	0700-Along Cross Result	61 0 61	S 160	213	47 21 51	S on 184	North	61 S	45 5 45	S on 166	
13	1300-Along Cross Result								51 8 52	S on 169	
13	1900-Along Cross Result								45 5 45	S on 166	
14	0100-Along Cross Result								18 2 18	S off 154	
14	0700-Along Cross Result	51 8 51	S off 151	165	76 19 79	S on 174	North	34 S	49 2 49	S on 162	
14	1300-Along Cross Result								28 3 28	S on 166	
14	1900-Along Cross Result								21 2 21	S off 155	
15	0100-Along Cross Result								2 6 6	N on 268	
15	0700-Along Cross Result	0 5 5	S off 70	238	55 28 62	N off 7	North	14 N	13 0 13	S 160	
15	1300-Along Cross Result								7 8 11	S on 209	
15	1900-Along Cross Result								9 1 9	S off 154	

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on = onshore off = offshore

TABLE 4: Current Data  
MAR 1987

Day	Time	Pier Measurements				Beach Measurements				Current Meter		
		Alongshore Cross-shore Resultant Speed	Dye at (579 m) (surface)	Distance from Baseline (m)	Dye at Mid-Surf Zone (surface)	Speed	Dir	(500m Updrift)	Dye 12m offshore (surface)	Location	Speed	Dir
16	0100-Along Cross Result	-	-	-	-	-	-	-	-	-	16	S on
16	0700-Along Cross Result	34 0 34	S 160	213	34 34 48	S on 205	-	no observation	-	-	25 6 26	S on 173
16	1300-Along Cross Result	-	-	-	-	-	-	-	-	-	36 8 37	S on 173
16	1900-Along Cross Result	-	-	-	-	-	-	-	-	-	24 8 25	S on 178
17	0100-Along Cross Result	-	-	-	-	-	-	-	-	-	18 3 18	S on 169
17	0700-Along Cross Result	41 0 41	S 160	177	44 11 45	S on 174	-	no observation	-	-	24 2 24	S on 165
17	1300-Along Cross Result	-	-	-	-	-	-	-	-	-	21 7 22	S on 178
17	1900-Along Cross Result	-	-	-	-	-	-	-	-	-	15 4 16	S off 145
18	0100-Along Cross Result	-	-	-	-	-	-	-	-	-	4 2 4	S on 187
18	0700-Along Cross Result	38 0 38	S 160	152	51 8 51	S on 169	North	56	S	23 5 24	S on 172	
18	1300-Along Cross Result	-	-	-	-	-	-	-	-	-	17 7 18	S on 182
18	1900-Along Cross Result	-	-	-	-	-	-	-	-	-	14 0 14	S off 160
19	0100-Along Cross Result	-	-	-	-	-	-	-	-	-	11 5 12	S on 184
19	0700-Along Cross Result	5 1 5	S off 146	140	0 13 13	on 250	North	11	N	0 0 0	-	
19	1300-Along Cross Result	-	-	-	-	-	-	-	-	-	3 8 9	S on 229
19	1900-Along Cross Result	-	-	-	-	-	-	-	-	-	6 6 8	S on 205
20	0100-Along Cross Result	-	-	-	-	-	-	-	-	-	5 6 8	S on 210
20	0700-Along Cross Result	24 0 24	S 160	128	25 3 26	S on 166	North	16	N	2 5 5	N on 272	
20	1300-Along Cross Result	-	-	-	-	-	-	-	-	-	14 5 15	S on 180
20	1900-Along Cross Result	-	-	-	-	-	-	-	-	-	2 6 6	S on 232

KEY = All speeds in CM/SEC

N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

TABLE 4: Current Data  
MAR 1987

Day	Time	Pier Measurements				Beach Measurements				Current Meter at South Tripod	
		Alongshore Cross-shore Resultant	Dye at (579 m) surface	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	(500m Updrift)	Depth -4.8m (NGVD)
21	0100-Along Cross Result									2	N off 7
21	0700-Along Cross Result	41 0	S	152		51 10	S on	54	S	4 4	S on 205
21	1300-Along Cross Result	41 160				52 171		North		6	
21	1900-Along Cross Result									21 8	S on 181
21										22	
22	0100-Along Cross Result									1	N on 259
22	0700-Along Cross Result	23 7	S off	128		21 3	S off	26	S	2 21	S off 155
22	24 143					21 151		North		5 5	S on 239
22	1300-Along Cross Result									22 5	S on 173
22	23 23									23	
22	1900-Along Cross Result									16 1	S off 156
23	0100-Along Cross Result									16 1	
23	0700-Along Cross Result	55 6	S off	238		24 12	S on	no observation		1 7	S on 205
23	56 154					27 187				13	
23	1300-Along Cross Result									36 2	S on 163
23	23 163									36	
23	1900-Along Cross Result									25 4	S on 169
23	25 25									25	
24	0100-Along Cross Result									21 0	S
24	0700-Along Cross Result	29 3	S off	238		34 14	N off	27	S	17 5	S on 160
24	29 154					36 2		North		18	
24	1300-Along Cross Result									12 1	S off 155
24	12 12									12	
24	1900-Along Cross Result									5 8	S on 218
24	5 8									9	
25	0100-Along Cross Result									3 1	S off 142
25	0700-Along Cross Result	29 12	S on	189		20 3	S off	no observation		3	
25	31 182					21 151				1	
25	21 151									3	
25	1300-Along Cross Result									8 5	S on 192
25	8 5									9	
25	1900-Along Cross Result									5 0	S
25	5 0									5	
25	25 160									160	

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on = onshore off = offshore

TABLE 4: Current Data  
MAR 1987

Alongshore Cross-shore Resultant Time Day	Pier Measurements						Beach Measurements						Current Meter at South Tripod Depth -4.8m (NGVD) ID #679
	Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	(500m Updrift)	Dye 12m offshore (surface)	Location	Speed	Dir	
26 0100-Along Cross Result											6	N	
											1	off	
											6	349	
26 0700-Along Cross Result	6 13 14	N off 46		189		76 27 81	N off 359	North	78	N	8 1 8	N on 333	
26 1300-Along Cross Result											13 4 14	N on 323	
26 1900-Along Cross Result											7 1 7	N off 348	
27 0100-Along Cross Result											10 1 10	N off 346	
27 0700-Along Cross Result	18 0 18	N 340		128		76 0 76	N 340	South	13	N	7 0 7	N 340	
27 1300-Along Cross Result											10 1 10	N on 334	
27 1900-Along Cross Result											2 2 3	N off 25	
28 0100-Along Cross Result											6 1 6	N on 331	
28 0700-Along Cross Result	44 0 44	S 160		165		3 1 3	N on 326	North	12	N	6 0 6	N 340	
28 1300-Along Cross Result											19 2 19	S off 154	
28 1900-Along Cross Result											43 8 44	S on 171	
29 0100-Along Cross Result											32 7 33	S on 172	
29 0700-Along Cross Result	41 4 41	S on 166		213		12 20 23	S on 220	North	44	N	18 2 18	S on 166	
29 1300-Along Cross Result											13 6 14	S on 185	
29 1900-Along Cross Result											6 1 6	S on 169	
30 0100-Along Cross Result											18 5 19	S on 176	
30 0700-Along Cross Result	16 0 16	N 340		165		51 5 51	N off 346	South	44	N	2 1 2	S on 187	
30 1300-Along Cross Result											4 2 4	S on 187	
30 1900-Along Cross Result											9 0 9	N 340	

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N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

TABLE 4: Current Data  
MAR 1987

Day	Time	Pier Measurements				Beach Measurements				Current Meter	
		Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed
31	0100-Along Cross Result									15	N
										5	on
										16	322
31	0700-Along Cross Result	76 11 77	N off 349		213	102 25 105	N off 354		South	134	N
										24	N
										2	on
										24	335
31	1300-Along Cross Result									19	N
										1	off
										19	343
31	1900-Along Cross Result									26	N
										0	
										26	340

KEY = All speeds in CM/SEC

N = Northward, Shore parallel

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on = onshore

off = offshore

## V. SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) taken at the seaward end of the pier are made of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves) but not surface chop or capillary waves. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring alignment of the wave crests. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 east of true north; consequently, wave angles greater than 70 imply the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are made daily at the seaward end of the FRF pier. A jar along with a thermometer is lowered about .3 m (1 ft) into the water and allowed to remain for at least one minute. The jar is removed, the temperature read and a hydrometer is used to determine the density. A secci disc is used to determine the surface visibility.

TABLE 5  
SUPPLEMENTAL OBSERVATIONS

MAR 1987

DAY	TIME	WAVE APPROACH ANGLE AT PIER END		RADAR WAVE ANGLE deg from True N	WIDTH OF SURF ZONE(m)	WATER CHARACTERISTICS AT PIER END		
		Primary	Secondary			TEMP(C)	DENSITY (g/cc)	SECCI VIS(m)
1	1030	90	130	120	351	5.0	1.0248	0.6
2	811	95	150	80	152	4.7	1.0252	0.6
3	848	50			15	5.2	1.0245	2.1
4	820	70	50	50	168	5.8	1.0220	1.5
5	820	60		70	268	5.1	1.0200	0.9
6	834	95		80	149	4.9	1.0202	1.8
7	945	110			85	5.9	1.0200	1.5
8	1023	120			50	5.2	1.0234	1.8
9	730	70			27	7.1	1.0200	1.5
10	730			10	631	7.1	1.0200	0.6
11	750	50		65	658	4.1	1.0235	0.3
12	740	60		80	439	4.7	1.0212	0.3
13	752	50		70	468	4.5	1.0208	0.6
14	950	60		65	283	4.6	1.0202	0.9
15	920	70		75	415	4.7	1.0232	0.6
16	740	50	100	50	302	5.1	1.0225	1.2
17	756	40		40	273	4.6	1.0223	0.9
18	745	25		75	110	4.9	1.0219	1.2
19	821	40		40	98	5.0	1.0213	1.8
20	820	85	30	55	12	5.0	1.0204	2.7
21	945	30		40	79	5.2	1.0204	2.7
22	845	80	30		3	5.8	1.0206	2.4
23	900	50		70	415	5.8	1.0212	0.9
24	740	70		70	381	6.0	1.0204	1.2
25	800	40		40	302	6.1	1.0207	1.2
26	816	50		40	126	6.1	1.0234	0.6
27	800	90			6	5.7	1.0240	1.8
28	1045	10		inoperative	98	6.5	1.0246	0.9
29	1100	50			238	9.9	1.0188	1.5
30	826	120			152	9.6	1.0195	1.8
31	715	105		80	393	7.1	1.0210	0.6

## VI. WATER LEVELS

The National Ocean Services (NOS) has established a primary tide station (No. 865- 1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect data every 6 minutes throughout the month.

Figure 4 shows the variation in mean water levels computed over a tidal cycle period (12.42 hours), and contains a list of selected mean and extreme values. This presentation is useful in identifying effects on both meteorological and astronomical forces on the open coast water levels.

Table 6 contains the time of the center of each sampling interval and the range, high, low, and mean water levels during each tidal cycle.

FRF TIDE HEIGHTS  
MAR 1987

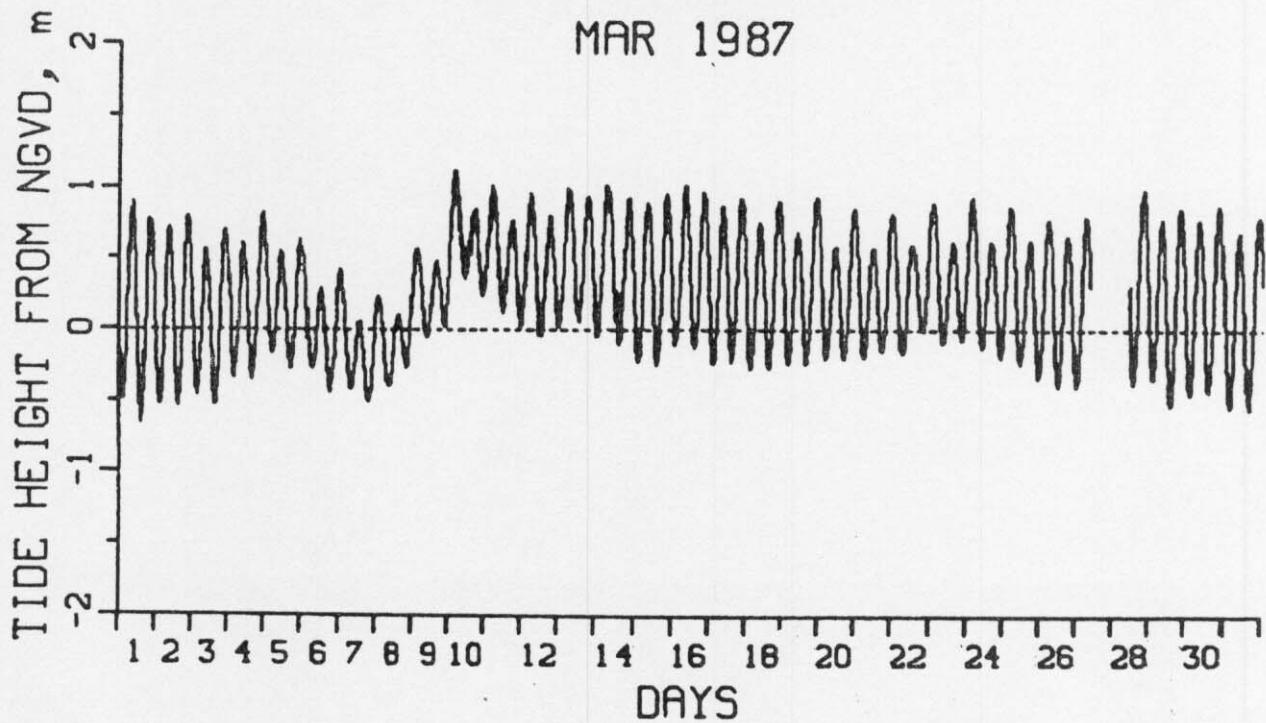


FIGURE 4. Time History of Mean Water Levels, March 1987

MONTHLY WATER LEVELS (METERS MSL)

Extreme Low -	-0.66 on 1 March at 1406 hrs.
Extreme High -	1.11 on 10 March at 0348 hrs.
Monthly Mean -	0.25
Mean Low -	-0.24
Mean High -	0.74
Mean Range -	0.98

Table 6: WATER LEVELS (METERS NGVD)

MID-CYCLE DAY	TIME	LOW	HIGH	MEAN	RANGE
1	612	-0.50	0.89	0.18	1.39
1	1837	-0.66	0.77	0.09	1.43
2	703	-0.52	0.71	0.09	1.23
2	1928	-0.53	0.80	0.16	1.33
3	753	-0.46	0.56	0.04	1.03
3	2018	-0.53	0.69	0.14	1.22
4	843	-0.34	0.60	0.13	0.94
4	2109	-0.35	0.82	0.26	1.16
5	934	-0.17	0.54	0.15	0.71
5	2159	-0.27	0.63	0.17	0.90
6	1024	-0.31	0.29	-0.03	0.59
6	2249	-0.43	0.42	0.01	0.85
7	1115	-0.46	0.05	-0.21	0.51
7	2340	-0.50	0.23	-0.11	0.73
8	1205	-0.40	0.10	-0.14	0.49
9	30	-0.27	0.56	0.20	0.84
9	1255	-0.06	0.48	0.21	0.54
10	121	0.02	1.11	0.60	1.09
10	1346	0.35	0.84	0.60	0.48
11	211	0.24	1.00	0.60	0.77
11	1436	0.11	0.76	0.44	0.65
12	301	0.02	0.94	0.47	0.93
12	1527	-0.05	0.80	0.37	0.84
13	352	0.02	0.98	0.52	0.97
13	1617	0.05	0.93	0.48	0.88
14	442	-0.04	1.01	0.48	1.05
14	1707	-0.10	0.91	0.39	1.01
15	532	-0.23	0.89	0.33	1.11
15	1758	-0.24	0.96	0.37	1.20
16	623	-0.10	1.01	0.44	1.12
16	1848	-0.12	0.96	0.40	1.08
17	713	-0.24	0.87	0.30	1.11
17	1938	-0.22	0.92	0.36	1.14
18	804	-0.27	0.75	0.24	1.02
18	2029	-0.27	0.90	0.34	1.16
19	854	-0.23	0.69	0.20	0.92
19	2119	-0.24	0.93	0.38	1.17
20	944	-0.20	0.59	0.18	0.79
20	2210	-0.20	0.85	0.35	1.05
21	1035	-0.19	0.57	0.19	0.76
21	2300	-0.15	0.82	0.34	0.97
22	1125	-0.16	0.61	0.23	0.77
22	2350	-0.01	0.89	0.44	0.90
23	1216	-0.10	0.62	0.27	0.72
24	41	-0.07	0.92	0.43	1.00
24	1306	-0.12	0.62	0.25	0.74
25	131	-0.19	0.86	0.35	1.05
25	1356	-0.24	0.62	0.19	0.87
26	222	-0.33	0.77	0.23	1.11
26	1447	-0.40	0.67	0.14	1.07
27	312				
27	1537				
28	402			Gage Inoperative	
28	1628				
29	453	-0.35	0.77	0.21	1.12
29	1718	-0.53	0.86	0.18	1.38
30	543	-0.45	0.78	0.17	1.23
30	1808	-0.42	0.87	0.21	1.30
31	634	-0.53	0.69	0.07	1.23
31	1859	-0.55	0.79	0.16	1.34

## VII. NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Zeiss surveying system; a Zeiss Elta-2 first-order, self-recording electronic theodolite distance meter in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in February and the three surveys taken during March on profile line 188, located 517 m south of the pier. Significant changes to the entire profile are visible following a major storm which generated high waves from 10-16 March. On the foreshore (70 to 120 m), erosion occurred. In addition, a deep nearshore trough (120 m) developed and the nearshore bar (120 to 320 m) migrated 55 m shoreward. Offshore, the storm bar trough (320 to 360 m) deepened (up to .8 m) and the storm bar (400 m) shifted 70 m seaward. A surprising amount of accretion (up to .25 m) is also visible seaward of the storm bar (400 to 780 m).

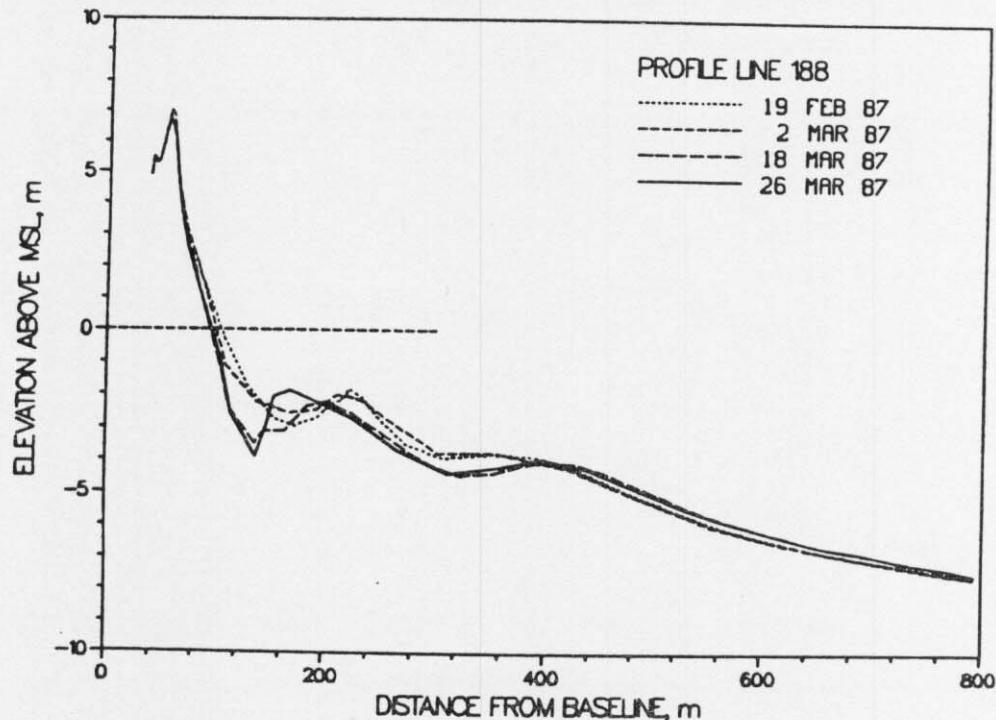


Figure 5. Monthly CRAB profiles on profile 188 - 517 meters south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile between February and March. The most significant changes are a result of the 10-16 March storm which deepened the nearshore and offshore troughs and accreted the seaward portion of the profile.

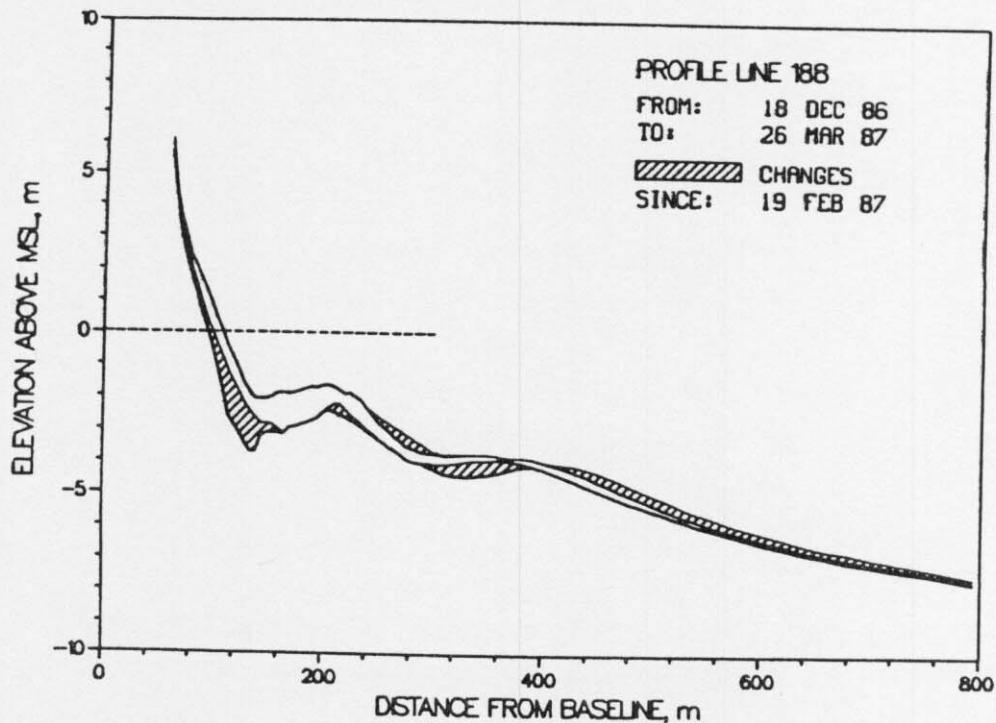
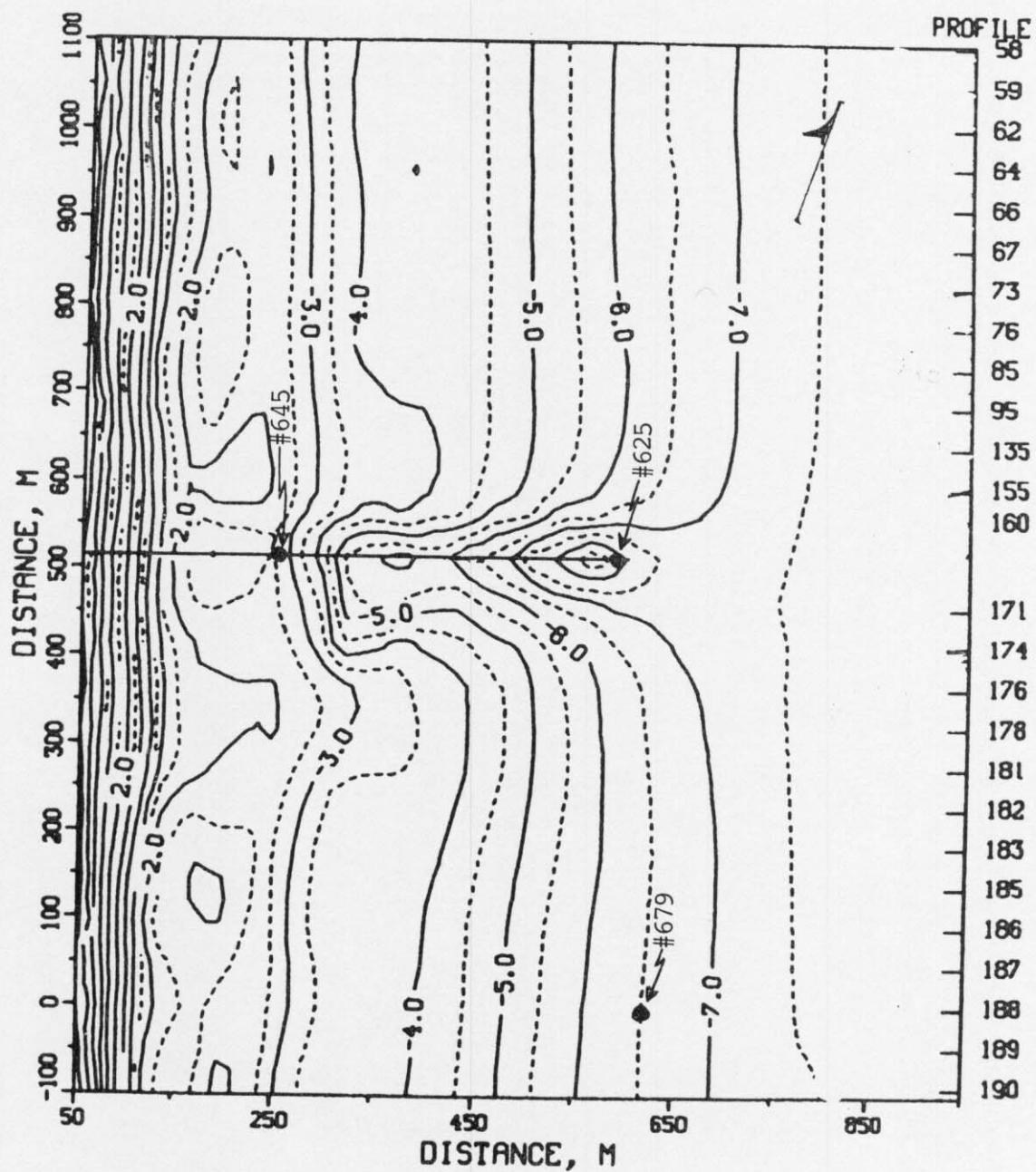


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 is a contour map showing the bathymetry around the pier on 3 March.



## VIII. SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when the wave height at the seaward end of the pier (i.e. as measured by the Baylor Gage #625 at pier station 19+00) exceeded 2 m. When this occurred, four contiguous 34-min wave records were obtained every hour:

<u>Start</u>	<u>End</u>
10 Mar (1442)	16 Mar (1708)
23 Mar (0808)	24 Mar (1142)
30 Mar (1634)	31 Mar (1034)

### B. Storm Synopsis.

10-16 March - Forming off Cape Hatteras, NC on 10 March, this intense storm was spawned from another low pressure system which had developed over the Gulf of Mexico and tracked northeast along the Appalachian Mountains. This storm quickly moved well offshore and was replaced by a smaller storm which formed off Virginia on 13 March and moved to the northeast. The minimum barometric pressure of 1001 mb was recorded on 9 March at 2042 hrs. Maximum onshore winds (NNE) exceeded 20 m/s at 0734 hrs on 10 March with the maximum Hmo (at Gage #625) of 3.36 m (period = 9.48 sec) recorded at 0700 hrs on the same day. The Hmo remained above 3 m for 28 consecutive hrs and above 2 m for 159 hrs. Total precipitation was 22 mm.

23-24 March - Onshore winds generated by a Canadian high pressure system produced storm waves at the FRF early on 23 March. Maximum winds exceeded 10 m/s and the maximum Hmo (at Gage #625) was 2.93 m (period = 12.20 sec); both values were recorded at 1300 hrs on 22 March.

30-31 March - Onshore winds produced by a combination of a Canadian high pressure system and a storm traveling along a cold front over the Appalachian Mountains briefly produced storm waves at the FRF. Maximum onshore (SSE) winds in excess of 11 m/s were recorded at 0842 hrs on 31 March. The minimum barometric pressure of 997 mb occurred at 0842 hrs on the 31st while the maximum Hmo (at Gage #625) of 2.09 m was recorded at 1742 hrs the same day. Total precipitation was 21 mm.

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